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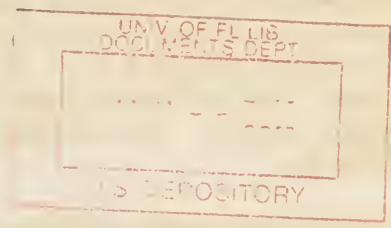
**EFFECT OF BOILING FOR VARIOUS PERIODS OF TIME
ON THE STRENGTH OF JOINTS IN BIRCH PLYWOOD
BONDED WITH UREA GLUE FORTIFIED WITH VARYING
AMOUNTS OF MELAMINE AND RESORCINOL**

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**UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
FOREST PRODUCTS LABORATORY
Madison, Wisconsin
In Cooperation with the University of Wisconsin**

EFFECT OF BOILING FOR VARIOUS PERIODS OF TIME ON THE STRENGTH OF JOINTS
IN BIRCH PLYWOOD BONDED WITH UREA GLUE FORTIFIED WITH
VARYING AMOUNTS OF MELAMINE AND RESORCINOL¹

By SYLVIA M. LECHER, Technologist

Boiling tests are commonly made on glued joints as a means of distinguishing urea glues, which are weakened by boiling, from glues, such as phenol, melamine, and resorcinol, that are not so affected. Because glues are on the market that are mixtures of urea resins and either melamine or resorcinol resins (commonly referred to as "fortified ureas"), information was desired on the effect of boiling on the strength of joints made with urea glues containing varying amounts of these fortifiers.

The purpose of the work here reported was to ascertain the effect of boiling for various periods of time on the strength of joints in birch plywood bonded with urea glues fortified with varying amounts of melamine or resorcinol.

The procedure was to prepare plywood panels with urea-formaldehyde glues containing various proportions of melamine-resin and resorcinol fortifiers, to boil shear specimens cut from these panels for various periods of time, and to determine the joint strengths of the boiled specimens by the standard plywood shear tests.

Resorcinol-fortified Urea-formaldehyde Glues

The urea-formaldehyde glue employed in this phase of the work was a liquid urea-resin solution containing 70 percent nonvolatile. To this solution was added various amounts of a resorcinol fortifier and appropriate amounts of a catalyst. The relative parts by weight of urea resin and resorcinol in the six glues tested (all formulated to produce hot-setting glues) are given in table 1.

The panels were made of three plies of 1/16-inch yellow birch heartwood veneer conditioned in an atmosphere of 80° F. and 65 percent relative humidity. A 4-hour closed-assembly time was allowed, and the panels were pressed for 4 minutes at 280° F. under a pressure of 250 pounds per square

¹This study was made during the war period at the request of the Air Technical Service Command of the Army Air Forces with funds provided by them for the purpose.

inch. One 24- by 24-inch panel was made with each glue. The specimens cut therefrom were selected so that specimens matched as nearly as possible were subjected to each of six exposure conditions. The specimens were conditioned for 1 week at 80° F. and 65 percent relative humidity before boiling and testing.

The results of the shear tests on these specimens before and after boiling are presented in table 1.

Melamine-resin-fortified Urea-formaldehyde Glues

The urea-formaldehyde glue employed in this phase of the work was a powdered urea-formaldehyde resin. To this resin were added various proportions of melamine resin and appropriate quantities of water. The relative proportions by weight of urea resin and of melamine resin in the nine glues tested are given in table 2.

The plywood panels were made in the same manner as described for the experiment with resorcinol-fortified urea glue, except that a 16-hour closed-assembly period was allowed and the panels were held under pressure at 280° F. for 8 minutes.

The results of the shear tests on these specimens before and after boiling are presented in table 2.

Conclusions

From the results of these experiments it appears that, except for rather low concentrations of fortifiers, periods of boiling in excess of 12 hours would be required to reduce the joint strengths of fortified urea glues below acceptable values. It would, therefore, be necessary to boil for periods longer than 12 hours in order to differentiate between such fortified urea glues and low-temperature phenol, melamine, or resorcinol glue.

Table 1.--Average results of shear tests on three-ply 3/16-inch birch plywood specimens, glued with a urea-formaldehyde resin glue fortified with resorcinol, before and after boiling in water

Glue:	Relative parts	Number:								
num-:	by weight	: of	: Dry ¹	: Wet ²	:	Boiling period ³				
ber :	-----	: speci-	:	:	:	3 hours	6 hours	9 hours	12 hours	
	:Urea-:Resorcinol:	mens :								
	:resin:	:tested:	:	:	:	:	:	:	:	
----	----	----	----	----	----	----	----	----	----	----
1	:100 :	0 :	120 :	⁴ 477-91 :	⁴ 573-96 :	⁴ 150-1 :	⁴ 54-1 :	⁴ 42-1 :	⁴ 23-0 :	
2	: 93 :	7 :	120 :	504-92 :	635-99 :	344-0 :	271-1 :	208-1 :	204-0 :	
3	: 87 :	13 :	120 :	523-88 :	657-100 :	453-42 :	428-32 :	394-11 :	391-7 :	
4	: 80 :	20 :	120 :	536-88 :	671-100 :	499-77 :	481-93 :	445-65 :	465-65 :	
5	: 73.5 :	26.5 :	120 :	516-94 :	601-100 :	536-91 :	491-49 :	492-84 :	469-69 :	
6	: 62 :	38 :	120 :	443-99 :	576-100 :	549-95 :	508-85 :	515-72 :	495-23 :	
	: :	:	:	:	:	:	:	:	:	

¹Tested dry after conditioning at 80° F. and 65 percent relative humidity.

²Tested wet after soaking in water 48 hours.

³Tested wet after boiling for the period designated.

⁴The first figure is the shear strength in pounds per square inch; the second figure is the wood failure in percent.

Table 2.--Average results of shear tests on three-ply 3/16-inch birch plywood specimens, glued with a urea-formaldehyde resin glue fortified with melamino resin before and after boiling in water

Glue:	Relative parts	Number:								
num-:	by weight	: of :	Dry ¹	: Wet ²	:	Boiling period ³				
ber :	-----	:speci-:	:	:	:	3 hours:	6 hours:	9 hours:	12 hours	
:	Urea-:	Melamine-:	mens :	:	:	:	:	:	:	
:	resin:	resin :	tested:	:	:	:	:	:	:	
----	----	----	----	----	----	----	----	----	----	----
1 :	100 :	0 :	156 :	433-98 :	480-99 :	113-3 :	48-0 :	40-0 :	40-0 :	
2 :	95 :	5 :	36 :	462-97 :	396-100 :	183-5 :	133-3 :	83-0 :	20-0 :	
3 :	90 :	10 :	36 :	428-95 :	484-94 :	302-5 :	212-0 :	196-0 :	160-0 :	
4 :	85 :	15 :	36 :	589-98 :	495-95 :	382-42 :	276-17 :	225-6 :	215-1 :	
5 :	80 :	20 :	120 :	454-100 :	518-100 :	421-78 :	339-30 :	302-21 :	330-32 :	
6 :	60 :	40 :	120 :	438-100 :	454-99 :	425-96 :	392-85 :	370-68 :	363-75 :	
7 :	40 :	60 :	120 :	472-95 :	498-100 :	431-89 :	408-78 :	410-80 :	409-73 :	
8 :	20 :	80 :	120 :	455-54 :	513-91 :	474-93 :	447-56 :	440-60 :	430-62 :	
9 :	0 :	100 :	120 :	419-57 :	495-97 :	518-95 :	449-87 :	445-86 :	434-92 :	
:	:	:	:	:	:	:	:	:	:	

¹Tested dry after conditioning at 80° F. and 65 percent relative humidity.

²Tested wet after soaking in water 48 hours.

³Tested wet after boiling for the period designated.

⁴The first figure is the shear ^{strength} in pounds per square inch; the second figure is the wood failure in percent.

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